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Imaging for new radiotherapy techniques

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Abstract

Radiotherapy could be considerably improved by the recent development of three-dimensional intensity-modulated radiation therapy. This technique allows the concept of so-called dose painting or adaptive dose distribution to be implemented with improved aligning of the dose distribution along the complex geometric arrangements of the tumour and the surround healthy critical structures. This enables the radiation dose in the tumour to be increasingly enhanced while sparing the normal tissue. Furthermore, many subfields enable the dose distribution within the tumour to be varied considering local differences in the functional tumour characteristics. Tumour heterogeneity or even variations in tumour volume and viability during radiotherapy may be considered. However, the success of the treatment increasingly depends on the capability of oncologic imaging tools to precisely localize and delineate the tumour and to provide information about its functional heterogeneity. The challenge in oncologic imaging is to improve and further develop novel concepts for precise tumour delineation and characterization. Important achievements in biologic imaging with morphologic functional computed tomography (CT), magnetic resonance imaging (MRI) and positron emission tomography (PET)/CT have the potential to modify the delineation of target volumes and to increase the dose in selected subvolumes. For example, novel PET markers of tumour hypoxia or proliferation have been developed for functional characterization of various tumour entities. Information from several other modalities such as dual energy CT, functional MRI (dynamic contract-enhanced MRI, diffusion-weighted imaging, arterial spin labelling, magnetic resonance spectroscopic imaging (MRSI), etc.) as well as from novel technological advances such as MR/PET may also be integrated in the radiotherapy plan. Data postprocessing with precise spatial coregistration of multimodal morphologic and functional imaging data as well as quality assurance aspects are still challenging. To overcome these problems novel concepts for hardware integration of CT and MRI with linear accelerators (CT/Linac, MR/Linac) are currently under development. The presentation outlines the current concepts of dose painting in radiotherapy for better planning and control of the final dose distribution and discusses the challenges and the potential of modern oncologic imaging in this context.

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